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The Rubber Content of Ammoniated Latex.

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The inception of commercial dealings in latex has given rise to a number of problems which are new to the rubber industry. One of the most important has been the development of rapid and accurate methods for evaluating the commodity. Up to the present, the method adopted has been an imitation of the standard estate practice whereby the latex is valued according to the dry weight of the solids which are coagulated by the addition of acetic acid.

The coagulation of fresh Hevea latex has received the attention of several investigators and recent studies by Belgrave (1) (2) have thrown considerable light on the phenomena with which we are familiar. With regard however, to the quantitative coagulation of ammoniated latex for commercial purposes our knowledge requires supplementing and the following article deals with some investigations which have been undertaken in this connection.

In the chemical laboratories of the Department of Agriculture during the past three years a large number of latex samples have been examined for rubber estates which are selling latex preserved by the addition of ammonia and observations made during this routine work are recorded here together with a summary of the results of investigations which have a bearing on this subject, and which have been confirmed by estate practice.*

Hevea latex, as it issues from the tree, is practically neutral, having a pH value in the neighbourhood of 6.8. As Belgrave has shown (2) this value changes fairly rapidly, first decreasing owing to loss of CO_2 and then increasing, owing to the development of bacteria and concomitant

*The F.M.S. Rubber Co., in collaboration with Mr. C. H. Hooper.

changes. The object of the addition of a preservative is to arrest the development of bacteria, and to prevent or suppress those changes which result in the coagulation of the rubber.

For commercial purposes, ammonia has been adopted as the most suitable preservative* and is generally used in the form of a twenty per cent aqueous solution of the gas. Owing to the fact that the latex is no longer absolutely fresh and has developed some acidity by the time the ammonia is added, it is found necessary to employ a generous excess of ammonia to correct the acidity of the latex and to provide for an appreciable loss during handling and transport. It is important that the alkalinity of the preserved latex shall remain outside the limits tolerated by the acid producing bacteria for it has been found that small proportions of ammonia only serve to neutralise the acid as it is formed and so provide a medium in which the development of bacteria is accelerated (4). In consequence of this the tendency has been to limit the use of ammonia only for reasons of economy without any regard to the possible effects which may be produced by storing latex under the influence of a powerful alkali. Some idea of these effects in an exaggerated form may be judged from the behaviour of latex to which excess of sodium hydroxide solution has been added. The liquid mixture soon separates into two well defined layers, of which the uppermost is a thick white cream or paste containing the caoutchouc, and the lower layer a brown liquid containing serum solids.

De Vries and Beumée-Nieuwland (5) have studied the behaviour of latex under the influence of large amounts of caustic soda and have shown that the paste separating from latex to which sodium hydroxide has been added contains a decidedly lower proportion of rubber than the paste separating from ammoniated latex. The latter was found to give a cream which contained 71-72 per cent of rubber by weight.

The additions to latex of smaller excesses of ammonia does not cause the brown liquor to separate so readily, but the caoutchouc creams to the surface and a grey precipitate is formed at the bottom of the container. This separation appears to be increased with increasing proportions of ammonia and by the presence of much air in the container but, even with the exclusion of all air and with the minimum proportion of ammonia requisite for preservation, some separation occurs (6). The precipitate may amount to 0.1 per cent by weight and contains magnesium-ammonium phosphate, and small quantities of iron sulphide.

The precipitate also retains an appreciable proportion of rubber. The amount varies according to the composition

* For comparisons of ammonia with other preservatives See De Vries, Arc. v. d. Rubbercultuur, March 1926, and O'Brien Rub. Res. Scheme Ceylon, Bull. 32 (1924) 7 & 8.

and source of the latex. It is of interest to note that Jelutong latex has also been observed to yield a rubbery precipitate when preserved with ammonia and stored.

With the optimum proportion of ammonia, latex will remain fluid for a long time; samples over four years old are still under observation, but there is an unavoidable change which takes place and which produces important effects when the latex is coagulated. When an acid such as acetic is added to latex the coagulation is brought about because the dissociation of the acid in solution causes the hydrogen ion concentration to rise to a certain critical point. If this point is not reached owing to the buffering action of dissolved salts the latex will not coagulate in the normal manner. Consequently when ammoniated latex is to be coagulated by the addition of acetic acid the amount must be sufficient to neutralise the free ammonia and to overcome the buffering action of the ammonium acetate which has been formed in the solution. It is found however that the critical point at which coagulation can take place is lower than in fresh latex. The longer the period during which the ammonia has acted the more marked are the changes in the coagulating properties of the latex. The significance of this is shown by the results of the following experiments:—

In Experiment No. 346 fresh latex having a dry rubber content of approximately thirty per cent was strained as free from dirt as possible and preserved by the addition of 2 parts by volume of 0.88 ammonia solution to 98 parts by volume of latex. The mixture was well shaken and stored in a dark glass container from which samples could be removed by suction into a pipette. Thirty minutes hand shaking preceeded the taking of a sample which was removed by a pipette, dropped into a tared beaker and rapidly weighed. The samples weighed approximately 100 grammes and determinations were in duplicate. Three comparative estimations of the rubber content of the latex were made.

(*A*) By evaporating at approximately 70°C in the air a thin film of latex spread on a glass plate under a fan.

(*B*) By adding 25 ccs of a 14 per cent acetic acid solution.

(*C*) By slowly dropping the latex into twice its volume of cold redistilled acetone.

The coagula from B and C were pressed, machined as thin as possible and dried to their minimum weights in an oven at approximately 70°C.

Table 1 records the results obtained and Diagram I* shows their relation to the period during which the latex has been preserved.

TABLE I.

Period of Preservation.	Rubber content of Latex. In parts per hundred by weight of fresh latex.		
	A. Evapo-ration.	B. Acetic Acid.	C. Acetone.
Fresh Latex Control. No Preservative	—	31.43	31.93
Latex + Ammonia After 1 hour -	34.41	31.63	31.26
do. „ 24 hours -	35.23	31.93	31.60
do. „ 48 hours -	34.01	31.34	31.10
do. „ 72 hours -	—	31.29	—
do. „ 192 hours -	33.73	31.09	31.05
do. „ 480 hours -	33.51	30.87	30.83
do. „ 720 hours -	33.45	30.82	30.66

In Experiment No. 351 a more concentrated latex was used for preservation and the amount of preservative added was 1.5 per cent by volume of 0.880 Ammonia.

Weighed quantities of the preserved latex were coagulated by three methods.

(*A*) Addition of excess of 14 per cent acetic acid.

(*B*) Dropping into twice its volume of 96 per cent alcohol.

(*C*) Evaporating to constant weight in a steam oven at approximately 98°C.

The results are recorded in Table II.

*See after page 11.

TABLE II.

Period of Preservation	Rubber Content of Latex. In parts per hundred by weight of fresh latex.		
	A.	B.	C.
Control. No Ammonia - 3-3-25	42.5	43.0	46.0
Latex plus Ammonia after 2 hours. -	43.37	—	46.23
„ 96 „ -	43.6	42.9	46.09
„ 144 „ -	43.6	43.1	46.45
„ 168 „ -	43.18	42.94	46.40
„ 264 „ -	43.45	42.55	46.35
„ 336 „ -	43.2	42.85	46.10
„ 1080 „ -	43.1	42.75	46.45
„ 1104 „ -	43.0	42.70	46.40
„ 1128 „ -	42.9	42.70	46.30
After standing until 18-10-26 -	38.90	38.22	42.70

From these and other results it is evident that the rubber content of ammoniated latex containing a minimum quantity of ammonia varies with the period of preservation and there is evidence from the figures in Table I. to show that the weight of the rubber produced rises slightly during the early stages of the preservation and then gradually decreases. It is interesting to note the fact that the peak weight of coagulum does not occur at the same period for all methods of coagulation. The figures in Table II confirm the previous results in a general manner although there are exceptional results for the weights of rubber produced by acetic acid and evaporation after 96 hours.

With a view to throwing further light on the influence of an acid coagulant experiments were conducted with different strengths of acetic acid.

In Experiment No. 356 a latex known to have a high rubber content was preserved by the addition of 2 parts by volume of 0.880 ammonia. The ammoniated latex was stored in a dark glass container which was shaken for 30 minutes before sampling. A sample of approximately 200c.cs was withdrawn daily. This sample was shaken in a stoppered bottle and six portions of 25c.cs were pipetted from it into tared beakers which were rapidly weighed. Coagulations were made with equal weights of 98 per cent acetic acid, 5 grammes in each case; but the acetic acid was diluted and used in the form of a 2 per cent, a 10 per cent and an 18 per cent aqueous solution. Duplicate coagulations were made with each strength of acid.

The mean weights of rubber obtained are recorded in Table III and their relation to the period of preservation is shown in Diagram II.*

TABLE III.

Date of Coagulation.	Rubber Content of Latex. In parts per hundred by weight of fresh latex.			
	2 per cent. acetic coagulation.	10 per cent. acetic coagulation.	18 per cent. acetic Coagulation.	Evaporation.
20-4-25 - Control latex before adding Ammonia. -	38.2	—	—	—
21-4-25 Ammoniated latex -	39.17	39.21	39.33	—
22-4-25 „ -	39.27	39.45	39.55	42.37
23-4-25 „ -	39.15	39.34	39.45	42.36
24-4-25 „ -	39.05	39.31	39.45	42.36
28-4-25 „ -	39.07	39.26	39.35	42.32
29-4-25 „ -	39.05	39.24	39.35	42.15
1-5-25 „ -	39.03	39.24	39.32	42.89

It can be seen from the figures recorded in Table III, that the weight of the coagulum varies according to the concentration of the coagulant and that owing to the presence of

*See after page 11.

the ammonia there is an appreciable difference in the weight of coagulum formed by the addition of acetic acid of different concentrations.

De Vries has shown (7) that the aqueous extract of crepe prepared from ammoniated or caustic soda preserved latex is consistently higher than the aqueous extract from untreated latex and the figures in Table IV, show to what extent this absorption is reflected in the weight of the rubber.

Samples of latex were treated with ammonia, 5 vols. of a 20 per cent ammonia solution to 100 vols. of undiluted latex, and coagulated at the same time as the original fresh latex within one hour of collection. The amount of acetic acid used for coagulating the ammoniated latex was equal to the amount used for the fresh latex plus the quantity required by titration to neutralise the ammonia. The coagula were creped and washed before drying to constant weight in an oven at 98°C.

The results are given in parts per hundred of the original untreated latex.

TABLE IV.

RUBBER CONTENT OF LATEX.

Before and After Addition of Ammonia.

Coagulations with 14 per cent Acetic Acid.

Date.	Weight of Coagulum From Latex alone.	Weight of Coagulum From Latex plus Ammonia.
	A	B
5.6.25	41.50	41.73 Diff. 0.23
4.7.25	42.04	42.22 Diff. 0.18
6.7.25	39.59	39.79 Diff. 0.20
7.7.25	42.49	42.78 Diff. 0.29
8.7.25	41.61	41.82 Diff. 0.21

The ammoniated latex contained 5 ccs of 20 per cent. ammonia solution to 100 ccs undiluted latex. This required 19.3 ccs of the 14 per cent. acetic acid for neutralisation.

Coagulations were carried out with 15 ccs of acetic acid for "A" and 34.3 ccs for "B".

The results recorded in Table IV show that the rubber coagulum although creped and washed is appreciably heavier when the latex has been ammoniated. It is not improbable that the increase in weight is dependent on the composition of the latex as well as on the concentration of the colloid, and further estimations undertaken with this object would be of value in establishing the true rubber content of ammoniated latex collected from trees of different ages of tapping.

The presence of ammonium acetate has not only the effect of increasing the weight of coagulum by reason of the proportion that is absorbed and coagulated with the colloid but as already pointed out, the ionisation, and, in consequence, the effectiveness of the coagulant is materially influenced. From what is known of the colloidal nature of latex it is evident that complete coagulation and the maximum weight of "rubber" cannot be obtained unless due regard is paid to the hydrogen ion concentration of the solution rather than to the titration value in terms of acid or alkali.

The practical significance of this can be seen from the results of coagulation when acetic acid is added to latex containing varying amounts of ammonium acetate. Diagram III* shows the hydrogen ion concentration of different mixtures and the effect which these have on the coagulation of the colloid. The latex contained approximately 40 per cent total solids by evaporation to constant weight at steam heat. The addition of ammonium acetate solution and acetic acid was made within an hour of collecting the latex. The hydrogen ion concentration was then determined after the solutions had been shaken for a few minutes. The hydrogen ion concentration is represented according to the pH notation by which low values signify high acidity. Belgrave (3) found that the pH value of latex determined colorimetrically gave fair agreement with electrometric determinations and in the present instance spotting with a series of indicators was the method adopted. The figures are however in the strictest sense only relative. It is interesting to compare these results with those obtained by De Vries with sodium acetate in his investigations on coagulation phenomena.

The limits of the region of perfect coagulation are dependent on the proportions of various components of the latex at the time of coagulation and when ammoniated latex is under consideration it is obvious that variations will occur.

Some figures illustrating these variations are given in Table V. The results were obtained by coagulating ammoniated latex one hour after adding the ammonia,—2 per cent by volume.

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*See after page 11.

Before adding the coagulant,—10 per cent acetic acid,—an amount equivalent to the ammonia was added for neutralisation. The specified volumes of acetic acid were then added to cause coagulation.

TABLE V.

Showing the variation in weight of coagulum from ammoniated latex by the addition of variable proportions of coagulant.

Coagulant. per 100 parts latex.	Weight of Coagulum per cent.					
	20th	21st	22nd	23rd	24th.	25th
Control plus 0.5 parts Acetic -	32.45	38.78	32.00	36.38	37.16	39.91
Ammonia latex Neutralised plus 0.5 parts Acetic -	32.47	38.86	32.18	36.40	—	—
Ammonia latex. Neutralised plus 1.0 parts Acetic -	32.51	—	32.56	36.56	37.33	40.16
Ammonia latex. Neutralised plus 2.0 parts Acetic -	32.64	38.98	32.69	36.66	37.41	40.24
Ammonia latex. Neutralised plus 4.0 parts Acetic -	32.55	38.20	32.74	36.54	37.16	40.00
Ammonia latex. Neutralised plus 6.0 parts Acetic -	32.50	38.02	32.73	36.44	37.16	39.90

The diminution in weight of the coagulum is explicable by the increased dilution caused by the large addition of liquid but it is evident from the figures that the weight of coagulum depends upon the proportion of coagulant which is added in excess of the quantity required to neutralise the alkali. The excess does not appear to have the same effect on different lots of latex and the variation in the weight of coagulum is not constant.

In the attached figures the minimum difference occurs on the 23rd and amounts to 0.43 per cent of the weight of the dry rubber, while on the 22nd the difference amounts to 1.7 per cent of the dry rubber.

In a further series of coagulations the weights of coagula were determined by the addition of 10 per cent acetic acid solution to fresh latex which contained ammonium acetate added in the form of a saturated solution. Table VI records the results of coagulations of latex collected on two successive days.

TABLE VI.

	Amount of Coagulant per 100 vols. latex.	pH of mixture.	Weight of Coagulum per 100 grms latex.	Remarks.
1ST DAY.	3.2 vols. Acetic -	4.8	42.33	Coagulum firm. Serum very slightly opalescent
	3.2 vols. Acetic + - 8.0 vols. Am Acetate	4.6	42.90	Coagulum firm. Serum absolutely water white and coagulation apparently perfect.
	4.0 vols. Acetic + - 8.0 vols. Am Acetate	4.6	42.98	Coagulum as above Serum water white
	8.0 vols. Acetic + - 8.0 vols. Am Acetate	4.4	42.70	Do.
	32.0 vols. Acetic + - 8.0 vols. Am. Acetate	4.2	42.50	Do.
2ND DAY.	1.6 vols. Acetic -	5.0	34.35	Coagulum pink, not firm. Serum cloudy.
	3.2 vols. Acetic -	4.6	34.35	Coagulum white and firm. Serum water white, and coagulation apparently perfect.
	1.6 vols. Acetic + - 8.0 vols. Am Acetate	4.6	34.42	Coagulum firm, serum water white and coagulation apparently perfect.
	3.2 vols. Acetic + - 8.0 vols. Am Acetate	4.4	34.48	do.
	8.0 vols. Acetic + - 8.0 vols. Am Acetat	4.2	34.37	do.
	32.0 vols. Acetic + - 8.0 vols. Am Acetate	4.0	34.33	do.

From these results it appears that for one day's latex the optimum coagulating point may be at a hydrogen ion value different from the optimum for some other days' latex. It is also evident that the appearance of the coagula and the clarity of the serums are not accurate indications of the completeness of the coagulation.

*The figures given in the tables above are "means" of two are more determinations. It has been calculated from a large number of coagulations that the variability in any series of triplicate determinations is of the order ± 0.03 for any one result.

Conclusions.

From the facts presented in the foregoing series of investigations it is obvious that the method of accurately evaluating latex on its rubber content as determined by acetic acid coagulation is not a simple process.

If the principal object is to obtain a coagulum of maximum weight then regard must be paid to factors concerning quantity of preservative, period of preservation and concentration of coagulant. Where concordant results are to be obtained it is necessary to elaborate the method and to provide for the differences which normally occur between latices from different estates under different conditions.

The writer wishes to express his best thanks to Major B. J. Eaton for his advice in this work and also to Mr. C. H. Hooper of the F.M.S.R. Co., for his very able collaboration in verifying the laboratory results recorded here by a series of investigations under estate conditions.

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(1) Belgrave W.N.C. - Studies on Hevea Latex. Malayan Agricultural Journal No. 12, Vol. XI.

(2) Belgrave W.N.C. - Studies on Hevea Latex. Malayan Agricultural Journal No. 12, Vol. XIII.

(3) Belgrave W.N.C. - Studies on Hevea Latex. Malayan Agricultural Journal. Vol. XI. No. 12 p. 362.

(4) De Vries. O. - Changes in Alkalinity of Ammoniated Latex. Archief voor der Rubber Cultuur March 1923.

(5) De Vries. O. - Archief voor der Rubber Cultuur August 1925.

(6) De Vries. O. - Influence of Ammonia on the Viscosity of Latex. Ibid. July, 1923.

(7) De Vries. O. - Archief voor der Rubber Cultuur. March and August, 1925.

(8) De Vries. O. - Archief voor der Rubber Cultuur. November, 1926.

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Diagram I.

Relation between Rubber Content and Duration of Storage.

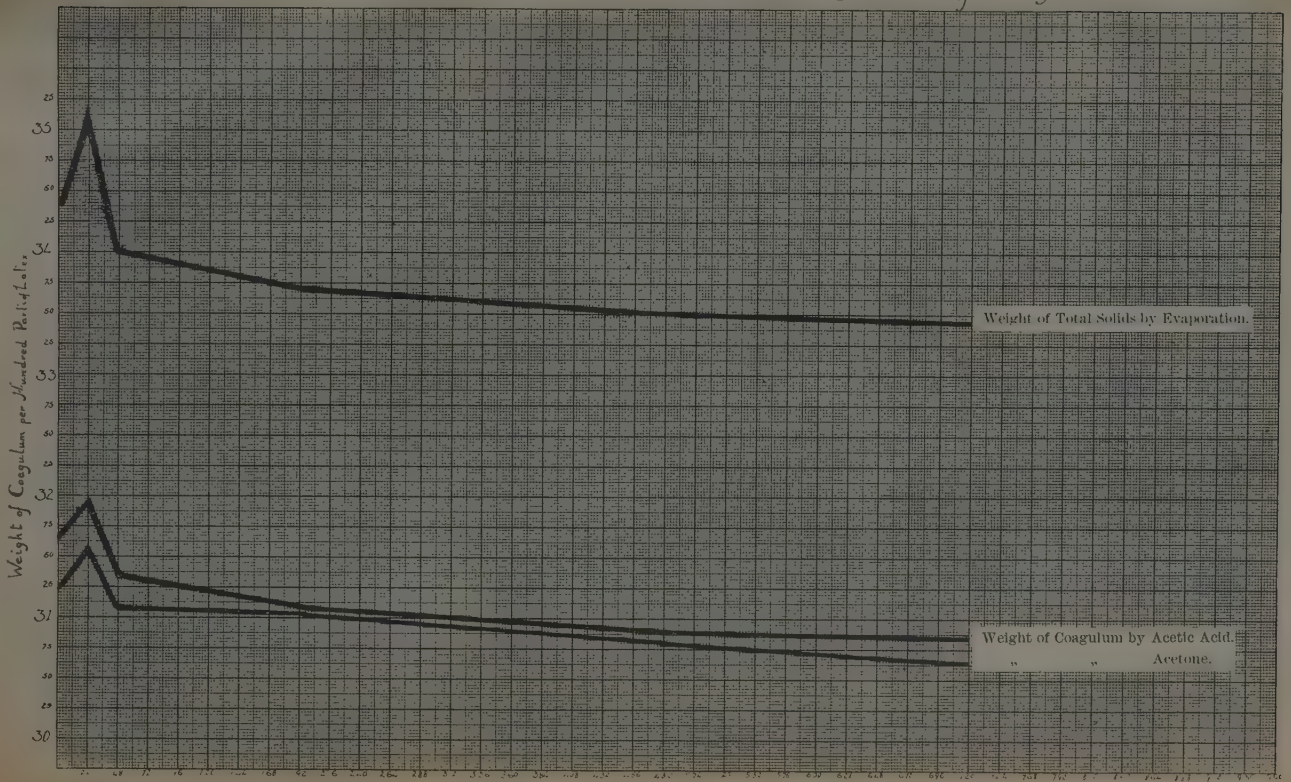
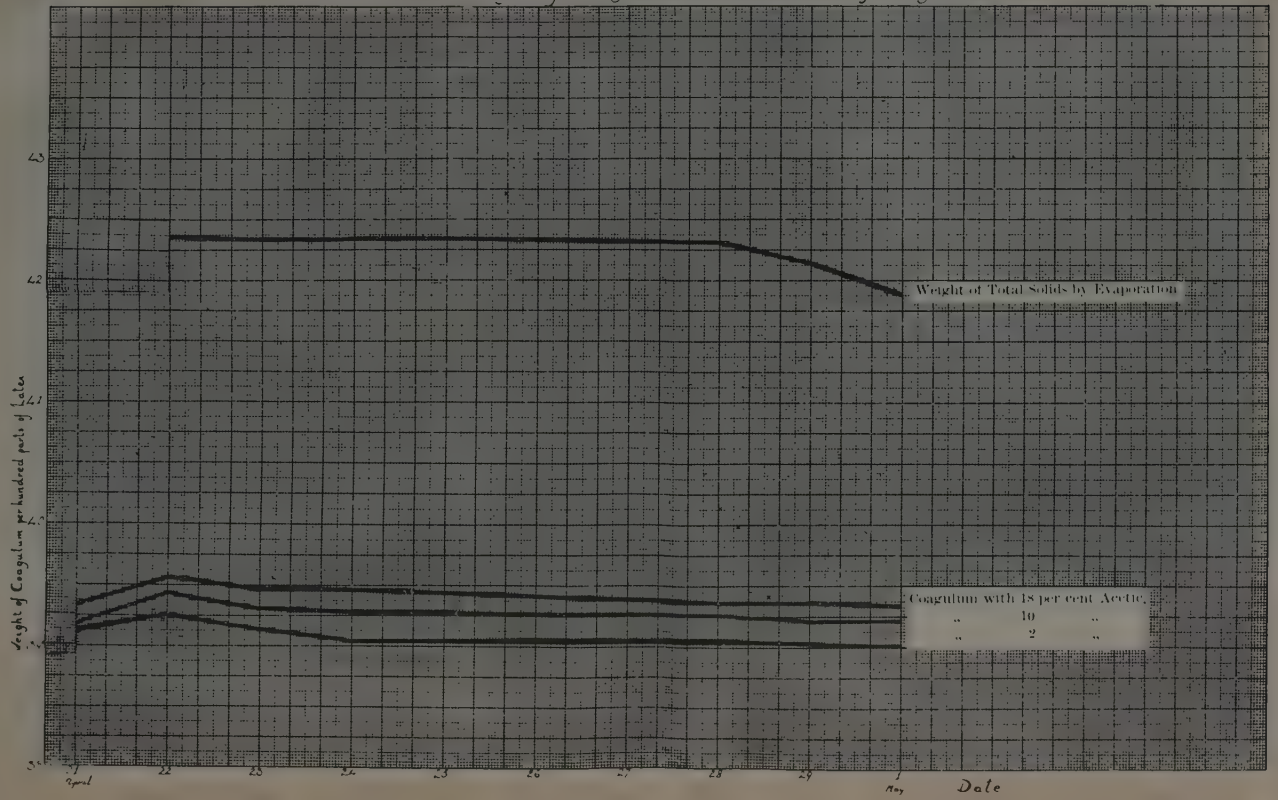
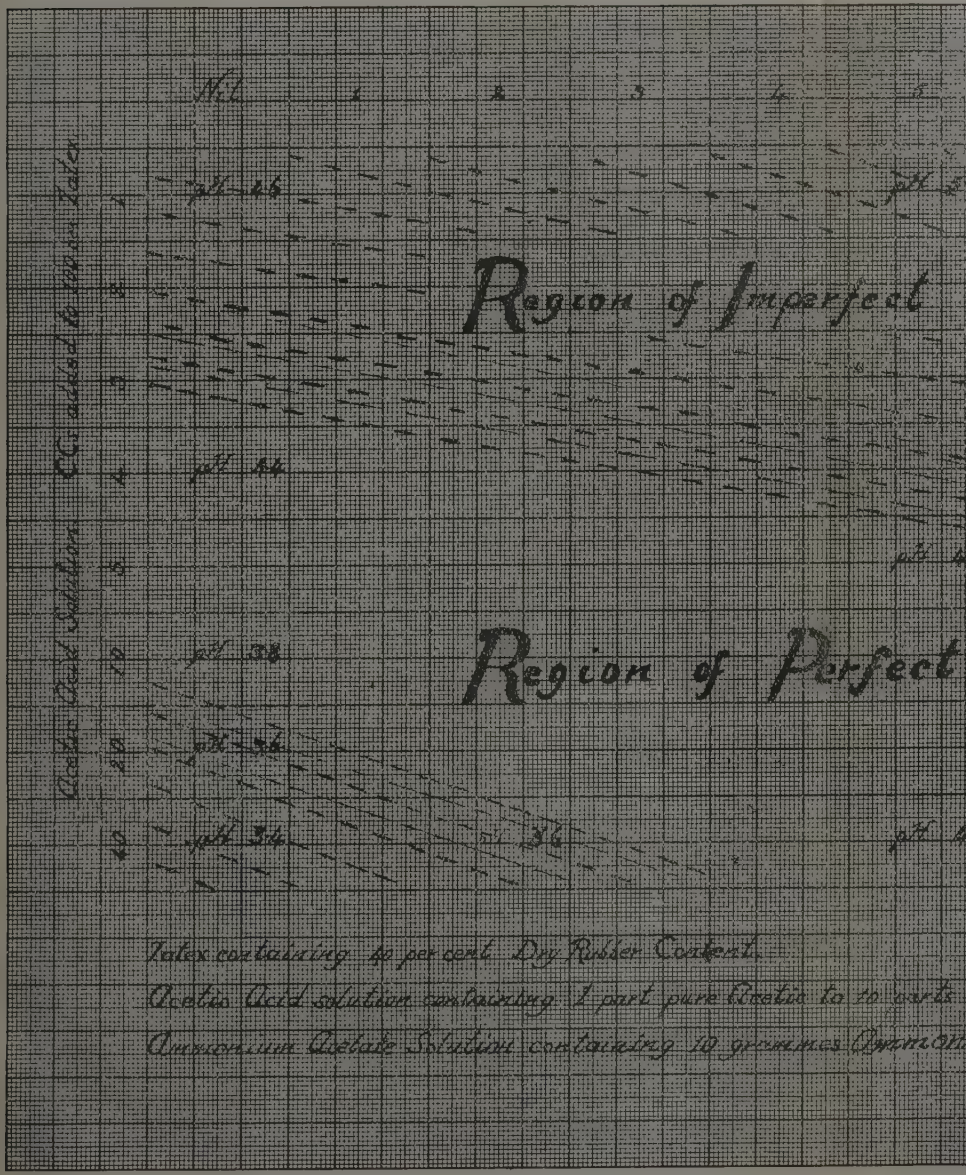


Diagram II.

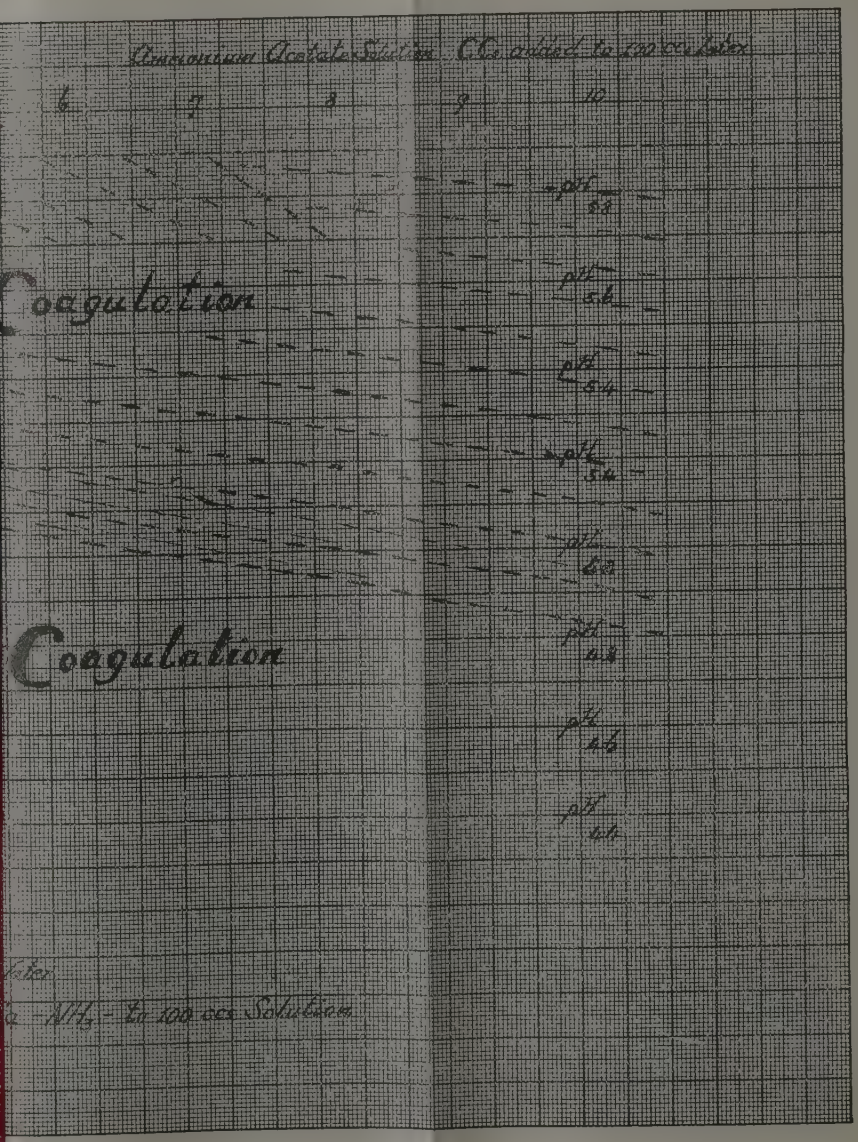
Relation between Weight of Coagulum & Concentration of Coagulant



Hydrogen Ion Concentration & Coagulation of L



tex with Ammonium Acetate & Acetic Acid.



The Experimental Cultivation of Sweet Potatoes at the Government Plantation, Serdang.

J. N. Milsum and E. A. Curtler.

The sweet potato, *Ipomoea Batatas* Lam., a herbaceous perennial with starchy tubers, forms an important root crop in most tropical and many sub-tropical countries. In the Malay Peninsula, it is extensively grown by Chinese vegetable gardeners both for their own consumption and sale in the local markets. The foliage is much used for feeding pigs and poultry. The sweet potato has always occupied an important place as a food crop in this country. It is undoubtedly a very useful emergency crop on account of its adaptability to cultural conditions and rapid maturity. The local price of the tubers is about four cents a kati = (1⅓ lb.).

In comparison with the ordinary potato, the sweet potato is stated to be somewhat deficient in nitrogenous substance, but contains more dry starchy and sugary matter. The tubers are recommended as a source of alcohol; a return of 35 gallons of 95 per cent. alcohol per ton of roots being obtained (2nd Memo. Finl. Rev. Bd. 1921, pages 2-8). The following analyses of the sweet potato and ordinary potato, extracted from the 'Tropical Agriculturist' Vol. LXII, No. 5, p. 318, shows the relative food values:—

Constituents.	Sweet Potato.	The Potato.
	per cent.	per cent.
Water -	70.36	76.22
Proteid -	2.04	2.21
Fat -	.87	.13
Carbohydrates -	24.31	19.94
Fibre -	1.33	.34
Ash -	1.09	1.29

Varieties.

Numerous varieties of this crop are recorded from different parts of the world. A collection of twelve varieties has

been established at the Government Plantation, Serdang. This collection comprises four distinct forms commonly grown in Malaya; varieties from the West Indies and Java, and one variety from the Philippine Islands. Owing to considerable variability of soil conditions of the several plots cultivated with these varieties, the results obtained cannot be regarded as strictly comparable. Further, there is as yet some uncertainty as to what is the most suitable distance of planting sweet potatoes under local conditions, and which is the best cropping season.

Description of Varieties Cultivated.

Local Varieties.—The four local forms have been collected from Chinese vegetable growers and others, living in the districts of Serdang and Sungei Besi in Selangor. They appear to represent the common races cultivated in the Malay Peninsula, though a variety maturing in two months or so is spoken of. Planting material of this sweet potato has, so far, not been secured. Local Nos. 1, 2 and 4, are distinguished by Chinese growers as commonly cultivated in South China, while Local No. 3 is stated not to occur in China.

Local No. 1.—Leaves 3½ ins. across, green, angular, 5 lobed, veins and immature foliage purplish. Stems not hairy. Flowers produced freely. Tuber large, usually irregular in outline. Skin pale pink; flesh yellow, blotched pale pink. An early maturing variety, being ready to lift in three months from planting. The Chinese consider this a good sweet potato for general purposes. It is valuable on account of its early maturing qualities.

Local No. 2.—Leaves large, 6 ins. across, dark green, divided, 5-7 lobed. Stems hairy. No flowers observed. Tuber large, globular. Skin faint brown, almost white. Flesh white. Matures in 4 to 5 months. The foliage of this variety is much used for feeding pigs.

Local No. 3.—Leaves large, 5 ins. across, dark green when mature. Young foliage light purple, usually slightly lobed at base. Stems hairy. Flowers produced freely. Tuber large, often over 9 inches long. Skin deep pink, flesh orange. Matures in 4 to 5 months. A very popular sweet potato. The tubers are grown for sale in the local markets and the foliage used for feeding pigs and poultry.

Local No. 4.—Leaves 4½ ins. across, dark green, undivided, cordate. Stems not hairy. Flowers produced freely. Tuber large, globular. Skin pale brown; flesh pale yellow,

blotched pink. Matures in about 3 months. This variety is less grown than the other local varieties.

West Indian Varieties.—These varieties were received from the Botanic Station, Montserrat, in December, 1923.

The recorded yield of these sweet potatoes in Montserrat is as follows:—

Variety.	No. of Experiments.	Average yield per acre.
North No. 3 -	20	11,802 lbs.
Victoria -	18	11,613 lbs.
Southern Queen -	15	11,310 lbs.

North No. 3.—Leaves 3½ ins. across, divided; veins, underside and ends of petioles purple. Stems not hairy. Few flowers produced. Tuber large tankard-shaped. Skin pale pink, flesh white. Matures in about 5 months from planting. This is becoming much sought after by Malays, who use the leaves and stems as a vegetable.

Victoria.—Leaves small, 2½ ins. to 3 ins. across, green, divided, 5 lobed. Stems not hairy. Flowers produced. Tuber large, tankard-shaped. Skin pale brown, flesh white. Reaches maturity in about 5 months.

Southern Queen.—Leaves large, 4½ ins. across, dark green, edges purplish when immature, base angular. Stems hairy. No flowers produced. Tuber medium-sized, oblong. Skin deep pink, flesh white. Reaches maturity in about 5 months.

American Variety.—One variety, New Jersey Red, was introduced by the Department of Agriculture in 1918 from the United States Department of Agriculture, Washington D.C. The tubers are of good quality, though the yields recorded are low. Possibly continuous cropping in this country has resulted in deterioration of this variety in respect of yield.

New Jersey Red.—Leaves 3½ ins. to 4 ins. across; green, veins and stems of immature foliage purple. Usually undivided, cordate. Stems hairy. No flowers seen. Tuber medium-sized, globular. Skin slightly pink, flesh pale yellow. Matures in about 6 months.

Java Varieties.—The three varieties of Java sweet potatoes were received in 1924, from the Plant Breeding Station for Annual Crops at Buitenzorg. They do not show

such distinct characters as the West Indian varieties and resemble in many respects those varieties grown in the Malay Peninsula. It appears desirable, however, to class them as distinct until it is possible to make more critical examination of the two groups.

Gedang.—Leaves 3½ ins. across, dark green when mature. Slightly lobed at base. Stems not hairy. No flowers seen. Tuber medium-sized, tankard-shaped. Skin pale brown, flesh yellow. Matures in 4 to 6 months.

Menesbodas.—Leaves 3½ ins. across, underside veins purple, divided, usually 5 lobed. Stems not hairy. Flowers produced. Tuber medium-sized, tankard-shaped. Skin pale brown, flesh white. Matures in about 5 months.

Samarinda.—Leaves small, 3 ins. across, green, divided. Divisions of the leaf narrow. Stems not hairy. Flowers produced. Tuber large, tankard-shaped. Skin pale brown, flesh white. Matures in 4 to 6 months.

Philippine Variety.—The single Philippine variety under cultivation was received from the Bureau of Agriculture, Philippine Islands in March 1924. At Serdang, it has always been a heavy cropper, producing large tubers of good eating qualities. In the Philippine Islands, Samar Big Yellow has proved to be a comparatively prolific seed producer and has been used in the production of new varieties of sweet potatoes, (Philippine Agriculturist, Vol. X, No. 5, 'Two years of Sweet Potato Breeding').

Samar Big Yellow.—Leaves 3½ ins. across, green when mature, deep purple when young. Variable in shape, usually broadly lobed. Stems slightly hairy. Flowers freely produced. Tuber large, tankard-shaped, flesh yellowish purple. Matures in 4 to 5 months.

Cultivation.

The sweet potato does not require a particularly rich soil to produce heavy crops. The Chinese frequently grow it in almost pure sand, relying on copious applications of liquid manure to provide sufficient plant nutriment. A sandy loam, without an excess of organic matter, is the most suitable soil for this crop. Chinese growers often bring 'lalang' land into cultivation with sweet potatoes as the first crop. Ridge culture should be employed to obtain heavy yields, and tubers of good shape and size. As previously stated, it is as yet a matter of some uncertainty as to what distance the ridges should be spaced apart to secure the maximum yields without undue exhaustion of the land. The usual system adopted at the Experimental Plantation,

Serdang, is to space the ridges three feet apart, from centre to centre, the ridges being raised to a height of 18 inches. The cuttings are spaced 15 inches apart in the rows.

Propagation is effected by cuttings of semi-mature portions of the stem. The cuttings should be about 9 inches long with 6 or more nodes, and may be planted about 3 inches deep in the soil. Owing to the difficulty of transporting soft-wooded cuttings in this country, the most satisfactory method of distributing stock has proved to be by tubers. These may be planted in small beds of sandy soil and the cuttings taken as they become available for planting out on the ridged land. It is a matter of importance to plant the cuttings during dull or rainy weather to enable them to root readily. The trailing stems of the plants should be turned back on to the ridges periodically, in order to prevent them rooting into the soil with a consequent decrease in the size of the main root tubers.

The time of harvesting the tubers is best ascertained by lifting a few roots and examining them. If they be cut through and the sap dries rapidly, forming a white crust, they are mature. Should the tubers be left in the soil for any length of time after maturity, they become very liable to the attacks of the Sweet Potato Weevil, *Cylas formicarius;* the adult weevils puncturing the skin. This pest was particularly prevalent at Serdang, on a crop of sweet potatoes that was in the soil for six months. The Chinese generally use the changkol for lifting the tubers, but the most satisfactory tool to use is the Assam fork. Considerable care is necessary when lifting the roots to prevent them from being bruised and subsequently rotting. In the humid climate of the Malay Peninsula, sweet potatoes do not store well and even when the tubers are undamaged, they frequently deteriorate by sending out growing shoots. To ensure a supply of fresh roots, it is advisable to plant up small areas only at a time so as to have continuous cropping.

Yields.

A number of experimental plantings have been made at Serdang during the past three years. The calculated yields are tabulated in Table I. The results obtained show considerable variation, due, it is thought to differences of soil and season. The weights recorded are those of sound tubers thoroughly cleaned of all soil.

The Philippine variety, Samar Big Yellow, has always yielded well. Of the West Indian varieties, North No. 3 and Victoria, have yielded fairly well, whilst Menesbodas and

Samarinda have proved good varieties. The local varieties have shown somewhat poor crops but improved returns were obtained in certain of the experiments.

TABLE I.

Calculated Yields of Sweet Potato Varieties under various Experiments in pounds per acre.

Variety.	Expt. I	Expt. II	Expt. III	Expt. IV	Expt. V	Expt. VI	Expt. VII
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Samar Big Yellow -	8340	10750	—	11160	9780	12580	8410
North No. 3 -	—	9040	9100	9130	8080	8450	7040
Menesbodas -	—	—	—	9400	6760	8620	5720
Victoria -	—	5320	5560	8690	8300	6600	5220
Samarinda -	—	—	—	9290	5830	4400	3790
Local No. 1 -	3100	—	3790	7970	7750	4970	4290
Local No. 3 -	1850	—	—	6160	5280	3740	6980
Local No. 2 -	3570	—	2040	3300	7810	4310	5940
Local No. 4 -	4420	—	2570	4400	5060	4700	5170
New Jersey Red -	—	2760	2420	1210	6380	5150	3960
Southern Queen -	—	2700	3180	1430	2970	3300	2310
Gedang -	—	—	—	1870	2640	1760	1700

Details of Experiments.

Experiment I.—The cuttings were planted on ridges 5 feet apart and 2 feet apart in the rows, requiring 4,356 cuttings per acre. The area of land planted with each variety was one-tenth of an acre. The land was unmanured but had been limed at the rate of one ton per acre for a previous crop of long-staple cotton. The crop was harvested in April, 1924. The foliage was cropped and disposed of to local Chinese for feeding pigs.

The following yield of fresh green matter was obtained:—

TABLE II.

Calculated Yield of Green Matter.

Variety.	Yield per acre. lbs.
Samar Big Yellow	9,680
Local No. 1	9,070
do. 2	9,640
do. 3	5,200
do. 4	6,730

Experiment II.—The cuttings were spaced one foot apart on ridges 4 feet apart, requiring 10,890 cuttings to plant an acre. The area of land planted with each variety was one-tenth of an acre. The crop was lifted in October, 1924. The land was unmanured.

The following yield of fresh green matter was obtained:—

TABLE III.

Calculated Yield of Green Matter.

Variety.	Yield per acre. lbs.
Samar Big Yellow	11,200
Southern Queen	6,140
New Jersey Red	5,850
North No. 3	4,120
Victoria	4,120

Experiment III.—The cuttings were planted on ridges 5 feet apart and spaced one foot apart on the ridges, requiring 8,712 cuttings to plant an acre. The area of land planted

with each variety was one-tenth of an acre. The land had previously been cropped with arrowroot and was manured for the sweet potatoes with cattle manure at the rate of about 10 tons to the acre.

Experiment IV.—In this experiment an attempt was made to obtain a fairly accurate comparison of the yields of the whole collection under similar conditions. Each variety was grown on four ridges, each ridge 3 feet wide and 1 chain long, i.e., 1/220th acre or 1/55th acre for each variety. The experiment consisted of 48 plots, each variety being planted in sequence with three guard rows at each end. The cuttings were planted 15 inches apart in the rows, requiring 11,616 cuttings per acre. The land had previously been cropped with tapioca and was limed for the sweet potatoes at the rate of one ton per acre. Cattle manure at the rate of 15 tons per acre was worked into the ridges. The crop was harvested in July, 1925.

Experiment V.—The cuttings were planted on ridges 3 feet apart and spaced 15 inches apart on the ridges, requiring 11,616 cuttings per acre. The area of land planted with each variety was one fifty-fifth of an acre. Cattle manure at the rate of about 10 tons per acre was dug into the ridges.

Experiment VI.—The ridges were spaced 3 feet apart and the cuttings planted 15 inches apart in the rows, requiring 11,616 cuttings per acre. The area of land under each variety was one forty-fourth of an acre. The previous crop on the land was ragi (*Eleusine coracana*). The land was manured for the sweet potatoes at the rate of 10 tons of cattle manure to the acre. Variety Local No. 1 was on the land just over three months and the other varieties about five months. The crop was harvested during the latter part of November, 1926.

Experiment VII.—This experiment was designed to see whether closer planting than usually adopted would result in increased yields. The calculated yields recorded in Experiments VI and VII, Table I, show this not to be the case. The ridges were spaced 2 feet apart and the cuttings 15 inches apart on the ridges, requiring 17,424 cuttings per acre. The area of land under each variety was one fifty-fifth of an acre. The land received exactly the same treatment and the crop was harvested at the same time as in experiment VI.

A good tuber of each variety was weighed, and the results are shown in the following table:—

TABLE IV.

Average weight of a good Tuber of each variety.

Variety.	Weight of Tubers. lbs.	ozs.
Local No. 1 -		14
do. 2 -	1	5
do. 3 -	1	3
do. 4 -	1	8
North No. 3 -	—	13
Southern Queen -	—	11
Victoria -	1	1
New Jersey Red -	—	12
Gedang -	—	11
Menesbodas -	—	8
Samarinda -	1	5
Samar Big Yellow -	1	—

SUMMARY.

A collection of twelve varieties of sweet potatoes is described.

2. Cultural notes on the crop are given.

3. The yields obtained from the varieties under several experiments are recorded. The calculated yields per acre show considerable variations due, probably, to varying conditions of soil and season and in certain cases to differences in distance of planting. The yields generally are somewhat low compared with those recorded from other countries. Sweet potato. Samar Big Yellow, is shown to be the highest yielder with an average calculated yield of about 5 tons of tubers per acre.

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Bud-grafting of Rubber Trees. Union of Stock and Scion.

F. G. Spring.

Observations have been made by the writer in respect of the influence of the age of the stock on the union of stock and scion

The following figures were obtained from trees grown at the Experimental Plantation, Kuala Lumpur. They were $4\frac{3}{4}$ years of age from time of budding to the date girth measurements were taken. The seedlings were 9 months old when budding was undertaken and the union of stock and scion is most satisfactory in respect of girth measurements at ground level and at 9 inches from the ground. These trees show scarcely any bulge at the point of union. Similar measurements were recorded from trees on Estate A where budding was carried out on $2\frac{1}{2}$ year old stock. These trees all show exceptionally bad union of stock and scion. The trunks bulge enormously at the base giving them a distinct club foot appearance.

Bud-grafted Trees at Experimental Plantation, Kuala Lumpur.

Difference in average girth at ground level and at 9″ from ground=6 inches.

Percentage difference in average girth at ground level and at 9″ from ground=22%

Difference in average girth at 9″ from ground and at 3′ from ground=4 inches.

Percentage difference in average girth at 9″ from ground and at 3′ from ground=19%

Bud-grafted Trees on Estate A.

Difference in average girth at ground level and at 9″ from ground=9 inches.

Percentage difference in average girth at ground level and at 9″ from ground=45%.

Difference in average girth at 9″ from ground and at 3′ from ground=2 inches.

Percentage difference in average girth at 9″ from ground and at 3 feet from ground=18%

It will be seen from the above that the percentage difference in average girth measurements at ground level and at 3 feet from the ground in the case of the trees budded on to when 9 months old is 22 while the percentage difference of average girth measurements taken at similar heights from trees on Estate A where budding was carried out on $2\frac{1}{2}$ year old stock is 45.

The percentage difference of average girth measurements at 9″ from the ground and at 3 feet from the ground is approximately equal in both cases.

Bud-grafting should be undertaken as soon as the seedlings are sufficiently large to permit of the operation being

carried out. The best age for stock seedlings is between 6 and 12 months old when there is a higher percentage of success, the work is easier and can be performed more speedily, less material is required and wounds are quickly concealed by rapid growth. When old seedlings e.g. 2½ years are cut back the exposed surface is so large and the healing process so slow that deterioration by infiltration of water may take place and cause rotting unless every precaution is taken.

Other factors, for instance, age of bud wood may have an influence on the growth at the point of union and although the age of the stock may not be entirely responsible for the swelling at the base of the trees yet it is considered of sufficient importance to draw attention to the advisability of budding on to young seedlings.

Bud-grafted Trees at Kuala Lumpur Experimental Plantation.—Budding was conducted in the nursery during August 1921, on stocks 9 months old which were subsquently transplanted into their permanent position in the field.

Girth measurements, in inches, taken at ground level, 9 inches from the ground and at 3 feet from the ground on the 12th of May, 1926.

Girth at ground level in inches.	Girth at 9 inches from ground in inches.	Girth at 3 feet from ground in inches.
30	26	21½
32½	28	22½
23½	21	15½
36	28½	23
25½	18½	16
36	26½	21½
26	17½	14½
22½	17	14
27	21½	15½
33	23	18½
30	22½	18½
19½	15½	13½
16	12½	11½
20	15½	14
34½	24½	19
21½	14	12
27½	22½	14
32½	22½	18
21½	18	14½
23½	16½	12½
25½	19	15½
30	24	18½
Average 27	21	17

Bud-grafted Trees at Estate A.

Year of planting in the field, 1921.

Year of budding in the field 1923.

Approximate age of stock when budding was commenced $=2\frac{1}{2}$ years. Girth measurements, in inches, taken at ground level, 9 inches from the ground and at 3 feet from the ground on the 11th September, 1925.

Girth at ground level in inches.	Girth at 9 inches from ground in inches.	Girth at 3 feet from ground in inches.
19	11	9
24	14	$12\frac{1}{2}$
21	$12\frac{1}{2}$	$10\frac{1}{2}$
21	12	$9\frac{1}{2}$
13	9	$6\frac{1}{2}$
18	10	8
20	$10\frac{1}{2}$	8
16	11	$7\frac{1}{2}$
18	9	$7\frac{1}{2}$
21	$11\frac{1}{2}$	$9\frac{1}{2}$
$20\frac{1}{2}$	$10\frac{1}{2}$	$9\frac{1}{2}$
21	14	9
17	10	7
25	$11\frac{1}{2}$	10
17	9	$7\frac{1}{2}$
20	11	9

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Three New Aleyrodids on Coconuts in Malaya.

G. H. Corbett.

Aleurocanthus gateri, sp.n. (Figs. A & B).

The pupa-cases on the leaf are crowded together, dense black in colour with a slight white waxy marginal fringe; elliptical in shape; length 1.12 mm., breadth 0.83 mm. Abdominal segments not distinctly marked; transverse suture conspicuous: dorsum with numerous heavy spines, the most prominent are five pairs of long spines, two pairs situated anteriorly on the thorax and three pairs on the abdomen—one pair just posterior to the transverse suture. In the mid-dorsal area, there are seven pairs of spines, two pairs between the anterior pair of long spines, a pair anterior to and two pairs just posterior to the transverse suture, and a pair anterior to and posterior to the vasiform orifice. In addition, in the subdorsal area of the thorax, there are four pairs, and of the abdomen, six pairs of small spines, the fourth pair being the longest. Exterior to these in the subdorsal and submarginal areas, there are four pairs of spines in the thoracic and twelve pairs in the abdominal region. (The number of these spines varies; specimens have been examined in which only five pairs are present between the first and second pairs of long spines on the abdomen, instead of the eight pairs, as shown in the figure). Margin dentate, the teeth being rounded and showing slight corrugations. A space of 0.1 mm. is occupied by 5-5½ teeth. At the base of the teeth forming a ring around the case is a series of minute pore-like areas. Vasiform orifice prominent, sub-cordate with a pair of small setae latero-anteriorly; operculum similar in shape obscuring the lingula.

This species is named after Mr. B. A. R. Gater who collected it on coconut leaves in Selangor, F.M.S., May, 1923. It has also been found on the African oil-palm.

Aleurocanthus cocois, sp. n. (Figs. D.E.F.G.).

Pupa case.—transparent yellowish-brown situated on under surface of leaf. Shape elliptical, margin slightly emarginate posteriorly; length 1.15 mm., breadth 0.76 mm. No dorsal or marginal secretion evident. A pore-like area extends from the margin to about the region of the bases of the submarginal spines and midway, a ring of 8 pairs of setae. Minute (?) pores are numerous throughout the sub-dorsal area, extending to the pore-like area. The transverse and thoracic sutures are distinct.

On the submarginal area, there is an irregular row of 40 spines, varying in length and extending some distance beyond the margin, on the subdorsal area, another irregular

row of 18 spines of uneven length, 4 pairs on the thorax and 5 pairs on the abdomen, and on the median area, 16 spines of unequal length, one pair on the thorax and seven pairs on the abdomen: a pair of setae, latero-anterior to vasiform orifice and on posterior margin of pupa case. The relative position of all the spines is indicated in the figure. Median ridge prominent, vasiform orifice elevated, subcordate, tending to circular and almost entirely filled by the operculum.

Margin dentate: teeth more prominent at posterior margin and 8—8½ occupy a space of 0.1 mm.

Collected at Batu Gajah, F.M.S., from coconut on the 16th. August, 1925.

Dialeurodes (Gigaleurodes) simmondsi, sp.n. (Fig. C.).

The pupae are stramineous in colour, very flat, closely applied to the leaves, without lateral or dorsal secretion and inconspicuously and irregularly situated on the lower surface of the coconut leaflets. In shape, the case is obovate; length 0.97 mm., breadth 0.69 mm. Margin very finely incised, emarginate at posterior extremity, and with a pair of small spines anteriorly and latero-posteriorly; marginal sutures fairly distinct extending towards the middle of the case: dorsum sparsely covered with regularly distributed small pores: tracheal and posterior pores not very prominent, linear and circular markings apparently absent from the folds; posterior fold more conspicuous than the tracheal folds. Thoracic and transverse sutures distinct. Cephalothorax and first abdominal segment with a pair of spines. Vasiform orifice without teeth on the inner posterior and lateral margins, small and subcordate. Operculum almost fills the orifice.

Collected on August 16th, 1925, at Batu Gajah, Perak, whilst with Mr. Simmonds, Government Entomologist, Fiji, and since on other dates, on fronds of coconut palms.

Explanation of Plates.

Aleurocanthus gateri Corbett, sp. n. A. Pupa case, B. margin of pupa case.

Aleurocanthus cocois Corbett, sp. n. D. Pupa case, E. margin of pupa case, F. margin and sub-marginal area of pupa case, G. Vasiform orifice and posterior margin of pupa case.

Dialeurodes (Gigaleurodes) simmondsi Corbett, sp. n. C. Pupa case.

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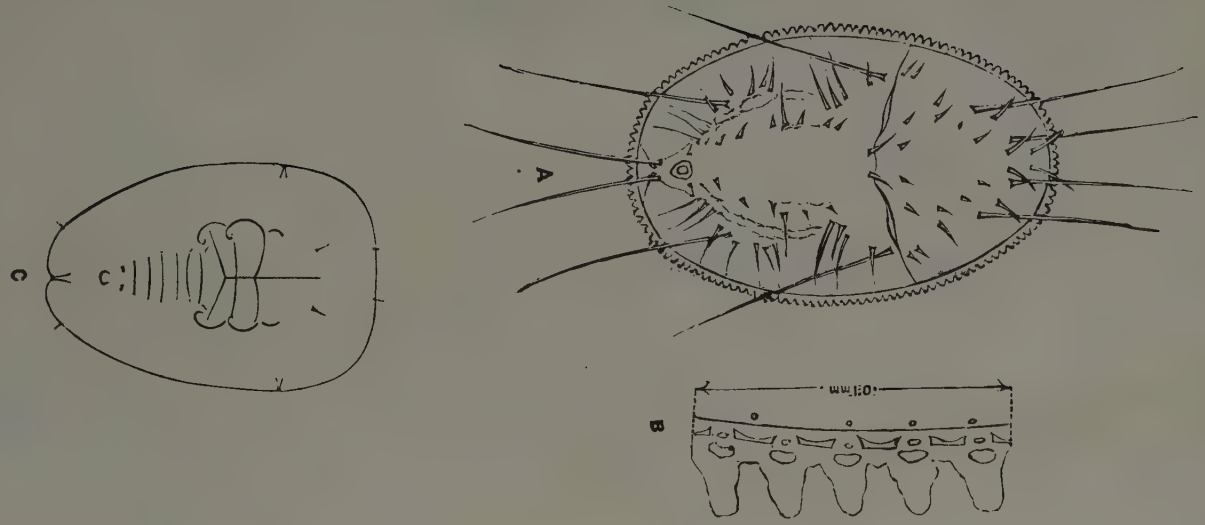
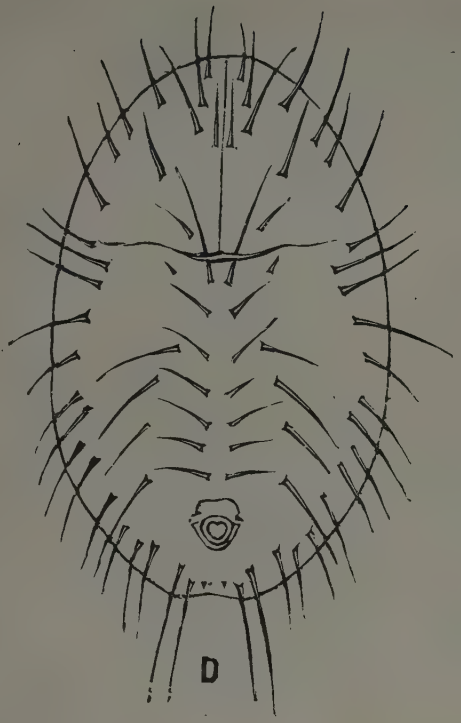
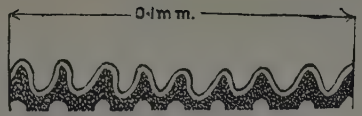

A
B
C





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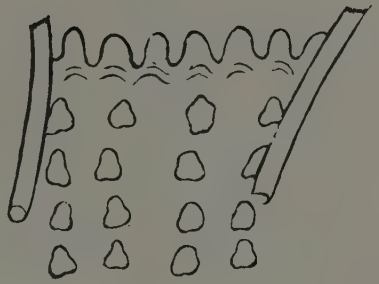

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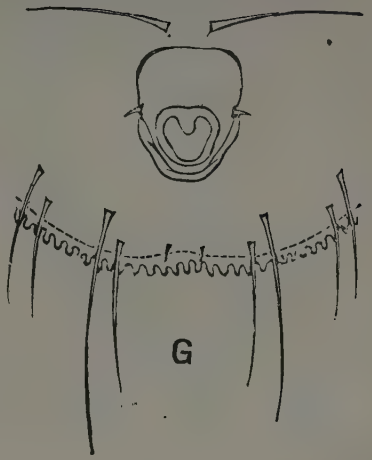

G

Plant Quarantine.

At the recent Pacific Science Congress held in Tokio this subject was discussed and, as the method used by the Bureau of Plant Industry at Washington, U. S. A., seems very sound, a brief note made from a paper read by Dr. Walter T. Swingle may be useful.

Dr. Swingle stated that, in his work on numerous species of citrus and related plants, it had been found possible to introduce such plants from all parts of the world without any risk of introducing new insect pests or fungous or bacterial diseases in spite of the fact that citrus fruit trees and their wild relatives are subject to the attacks of numerous insect pests, fungi and destructive bacteria. The method adopted is to retain the introduced plants in permanent quarantine in special metallic, isolated, insect-free propagating houses, until clean new growth, free from all signs of disease, is made. Then buds are cut from each clean new growth and grafted on vigorous, clean, young stocks of local origin and after such buds have started and if the new growth proves to be healthy and vigorous, the original imported plants are burned together with the pots and soil in which they were grown. The metallic screened cases in which plants had been growing are thoroughly sterilized both by heat and by washing with powerful disinfectants.

It had been found that although this procedure involved the destruction of every particle of wood, bark, leaf and roots which had been imported, it did not materially delay the rapid propagation of such material since the pest-free buds grafted on healthy home-grown stocks grow very rapidly—much more rapidly than the plants that had been transplanted at long distances, even if they looked sound and healthy on arrival.

Dr. Swingle was convinced that aseptic propagation in pest-free greenhouses was vitally important in safe-guarding all plant introduction, and considered that the procedure could be modified to get almost any kind of plant material. This new method, permitting the safe introduction of plants from all sources, is likely to be of great importance in guaranteeing to the plant breeder and to the student of new crops an adequate supply of all desirable plant material, no matter how drastic quarantine regulations may have to become in order to protect crop plants against injury from new pests or diseases.

H. W. J.

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Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price $5.00 per volume.
Vol. V (1917) Nos. 1, 2, 3, 5 & 6 ,, 2.50 per set.
Vol. VII (1919) ,, 2—6 ,, 4.50 per set.

(Vol. VI is out of print.)

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin) Published monthly.

Vol. X (1922) Price $5.00 per volume.
Vol. XI (1923) Price $5.00 per volume or 50 cents per single number.
Vol. XII (1924) ,, ,, ,, ,, ,,

Back numbers of Vols. I.—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased from the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, 1909, 20 cts.
2. Root Disease of *Hevea Brasiliensis*, by W. J. Gallagher.,
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18. Agriculture in Malaya, 1912, L. Lewton Brain, 1914. C
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23. The Tapping of the Para Rubber Tree, by E. Bateson, 1914, (out of print).
24. The Malayan Locust, by H. C. Pratt, Government Entomologist, and F. de la Mare Norris, Assistant Agricultural Inspector, 1915, 20 cts.
25. *Ustulina Zonata*—A Fungus affecting *Hevea Brasiliensis*, by A. Sharples, 1916, 20 cts.
26. Vegetable Culture in Malaya, by F. G. Spring, and J. N. Milsum, 1917, Second Edition 1919, (Out of print).
27. The Preparation and Vulcanisation of Plantation Para Rubber, by B. J. Eaton, J. Grantham and F. W. F. Day, 1918, $1.00.
28. A Wet Rot of Para Rubber, by W. N. C. Belgrave, 1919, (Out of print).
29. Fruit Culture in Malaya, by J. N. Milsum, 1919, (Out of print).
30. Food Production in Malaya, by F. G. Spring, and J. N. Milsum, 1919, $1.00.
31. Black Stripe and Mouldy Rot of *Hevea Brasiliensis*, by A. Sharples, W. N. C. Belgrave, F. de la Mare Norris and A. G. G. Ellis, 1920, (Out of print).
32. Observations on the Technique required in Field Experiments with Rice, by H. W. Jack, 1921, $1.00.
33. Wet Padi Planting in Negri Sembilan, by D. H. Grist, 1922, $1.00.
34. The Two-Coloured Coconut Leaf Beetle (*Plesispa reichei*) by G. H. Corbett, 1923, 50 cts.
35. Rice in Malaya, by H. W. Jack, 1923, $1.00.
36. "Red Stripe" Weevil of Coconuts (*Rhynchophorus schach*) by G. H. Corbett, 1924, 50 cts.
37. "Mouldy Rot" by F. W. South, and A. Sharples, 1925, 50 cts.
38. A Preliminary List of Food Plants of some Malayan Insects, by G. H. Corbett and B. A. R. Gater, 1926, 50 cents.

5. Warta Perusahan Tanah
Published in the Malay Language, distributed free from the Office of the Secretary for Agriculture.

C = Cancelled.

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„ „ „	(Penang & Province Wellesley)	F. R. MASON, Dip. Agr. H.A.-A.-C.
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Asst. Economic Botanist	„	W. N. SANDS, F.L.S.

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Asst. Mycologist	„	A. THOMPSON, B.SC.
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Agriculture—

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„ „	„	J. LAMBOURNE
Supt. of Govt. Plantations.	(Headquarters)	A. L. SINCLAIR.

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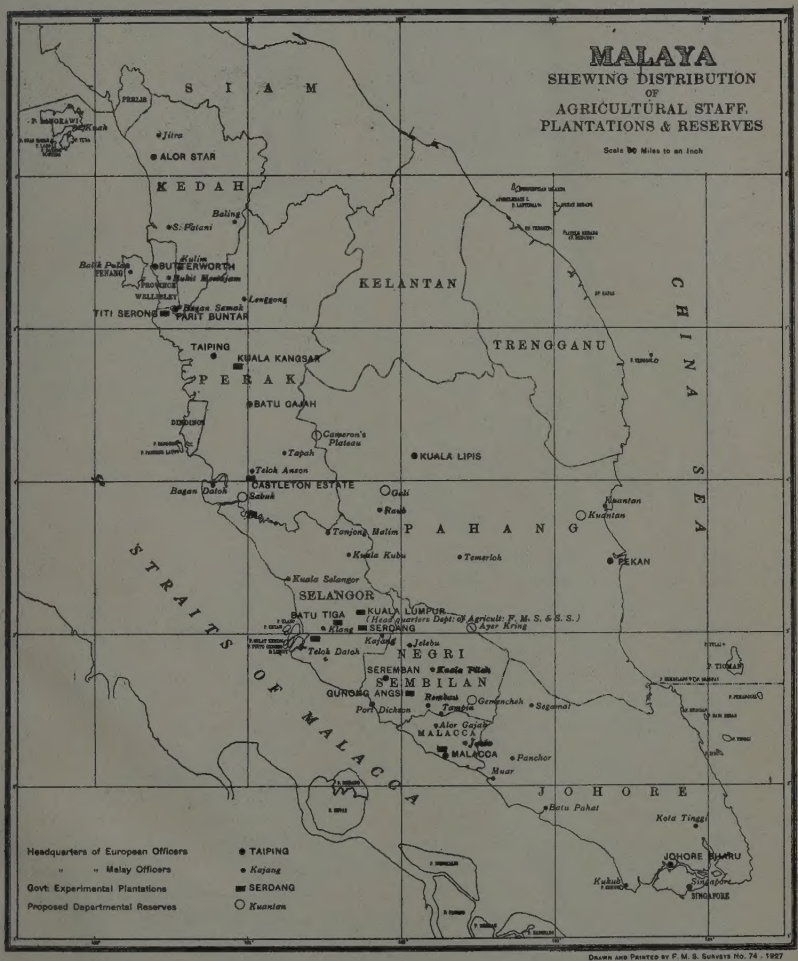
Plant Physiologist	(Headquarters)	W. N. C. BELGRAVE, B A., Cam. Dip. Agr.



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